Molecular imaging of human embryonic stem cells.

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Public Summary:
Much remains to be explained about the cellular underpinnings of stem cell biology prior to their therapeutic application. Although the pluripotency of ESCs is precisely what makes them attractive candidates for tissue regeneration, this property also creates a high risk of teratoma formation after cell transplantation. An additional hurdle to the implementation of cell transplantation therapy is the potential for host immune reactions against an allogenic stem cell graft. Also, one must ensure that the cell population delivered to the organism is homogenous in its differentiation fate and gene expression profile. These and other challenges highlight the need for the ability to track ESC engraftment, survival, and differentiation in vivo. The development of molecular imaging techniques potentially allows for the non-invasive, repetitive assessment of ESC-derived cell location, migration, proliferation, and differentiation in vivo. Here, we seek to highlight some of these applications.

Scientific Abstract:
Human embryonic stem cells (hESCs) are a renewable source of differentiated cell types that may be employed in various tissue regeneration strategies. However, clinical implementation of cell transplantation therapy is hindered by legitimate concerns regarding the in vivo teratoma formation of undifferentiated hESCs and host immune reactions to allogenic cells. Investigating in vivo hESC behaviour and the ultimate feasibility of cell transplantation therapy necessitates the development of novel molecular imaging techniques to longitudinally monitor hESC localization, proliferation, and viability in living subjects. An innovative approach to harness the respective strengths of various imaging platforms is the creation and use of a fusion reporter construct composed of red fluorescent protein (RFP), firefly luciferase (fluc), and herpes simplex virus thymidine kinase (HSV-tk). The imaging modalities made available by use of this construct, including optical fluorescence, bioluminescence, and positron emission tomography (PET), mat be adapted to investigate a variety of physiological phenomena, including the spatio-temporal kinetics of hESC engraftment and proliferation in living subjects. This chapter describes the applications of reporter gene imaging to accelerate basic science research and clinical studies involving hESCs through (1) isolation of a homogenous hESC population, (2) noninvasive, longitudinal tracking of the location and proliferation of hESCs administered to a living subject, and (3) ablation of the hESC graft in the event of cellular misbehavior.